

## APPENDIX J

**COMBAT OBSERVATION/LASING TEAM****Description**

The COLT is a high-technology observer team designed to maximize the use of *smart* munitions. Although originally conceived to interface with the Copperhead, a COLT can be used with any munition that requires reflected laser energy for final ballistic guidance. Thus, at present, the team can also lase for *smart* munitions delivered by Air Force and Army aircraft. Within the light forces structure, the team is composed of two soldiers equipped with a G/VLLD and the necessary mobility and communications assets. COLTs can also be used as independent observers to weight key or vulnerable areas. By use of the self-location and target-ranging capabilities of the G/VLLD, first-round FFE with conventional munitions can be achieved.

**Organization**

Each team is composed of one sergeant, who is the team chief and primary operator of the G/VLLD; and one specialist, who is the driver, RATELO, and secondary G/VLLD operator.

Each team is equipped with the following:

- ✂ One HMMWV with G/VLLD.
- ✂ Two radios – one AN/VRC-46 and one AN/GRC-160.
- ✂ One forward entry device.

**General Considerations**

The COLT laser (G/VLLD) can be used for target ranging and/or designation. A COLT can provide observation for both standard and laser-guided weapons. The G/VLLD is the current organic laser for light forces. However,

other Army (LTD and OH-58D helicopter) or Marine (modular universal laser equipment [MULE]) lasers may be available.

**Target Ranging**

COLTs can use the G/VLLD to provide accurate range, azimuth, and vertical angle to locate targets.

**Target Designation  
for Laser-Guided Weapons**

The LGW homes on reflected energy to attack a target. A G/VLLD can be used to designate for a variety of LGWs. These include 155-mm Copperhead (Army field artillery), Hellfire missile (Army aviation), Pave Penny (USAF), LGB (USAF), and Laser Maverick air-ground missile (Marine). For effective use of laser designators, certain criteria must be met:

- The PRF codes of the laser designator (G/VLLD) and the LST or LGW must be the same.
- ✂ Prearranged direction of attack (geometry to ensure necessary laser energy reflection is obtained) must be coordinated. For example, Copperhead firings require an angle T of less than 800 mils.
- ✂ The laser must lase at the correct time and for the required duration.
- ✂ The delivery system must place the LGW into the required footprint or envelope.

**Environmental Restrictions**

Laser designator and acquisition devices are designed to enhance current capabilities of fire support available to light forces. Several

factors – environment, laser system inherent limitations, and target types—affect laser employment. Tactics and techniques must take these factors into consideration.

**Line of Sight.** There must be line of sight between the designator and the target and between the target and the laser acquisition device or laser-guided weapon.

**Visibility Degradation.** Visibility can be degraded as discussed below.

*Clouds.* Clouds attenuate laser energy and degrade LST and LGW ability to see the spot. Since the laser spot is acquired only after the bomb comes out of the cloud, laser energy acquisition time is short; thus, ballistic accuracy is essential. Typical minimum ceilings and times of flight must be considered. In conditions of reduced visibility, present laser systems provide signal transmission ranges only slightly in excess of visual range.

*Darkness.* Laser energy transmission is unaffected by darkness, but darkness makes locating, identifying, and tracking targets more difficult for the COLT. The night sights for laser designators enhance operator target identification and engagement during night battlefield operations.

*Battlefield Obscuration.* Smoke, dust, and chemical particles in the air may attenuate or reflect the laser beam. This prevents sufficient energy reflection from the target for lock-on by LSTs or LGWs. Laser energy reflected from such particles also may present a false target to either the tracker or the munition. When faced with enemy obscurants, a COLT can reduce the impact by following some simple rules of thumb. Generally, if the observer can see a target through either day or night optics, he can successfully designate it. Positioning is key to reducing obscurant degradation of laser performance. Lasers should be positioned on the flanks or on

terrain where smoke is likely to be less heavy along the line of sight. Transferring the mission from a laser being obscured to an unobscured laser is another simple way to counter enemy obscurants and tactics. These techniques would require the use of COLTs in pairs or laser combinations.

*Concave Targets.* Tunnels and other targets that do not reflect laser energy cannot be directly laser-designated. Instead, the designator must be aimed at a nearby surface. For example, aiming the laser slightly above a tunnel opening would allow a weapon to impact at that critical point. For weapons that tend to miss short, like laser-guided bombs, this could guide the bomb to enter the tunnel opening.

*Obstructions.* Optimum positioning of ground laser designators is essential. Obstructions (trees, leaves, grass, and so forth) between the designator and the target may prevent a clear, unobstructed view for ground laser designator employment. Thus, jungle operations may preclude the use of ground designators and limit the effectiveness of airborne laser designators (ALDs).

*Temperature Extremes* Extreme temperatures affect battery-powered laser operation. For example, a cold, soaked battery may have a much-reduced capability to power the laser.

*Solar Saturation.* Laser seekers look for a spot of IR energy that stands out from the background. This can be a problem when engaging with low-angle LGWs or LST-equipped aircraft, especially against targets above the horizon just after sunrise and just before sunset.

## Seeker Characteristics

### Code

A laser seeker looks for laser designator energy on a specific PRF code. A designator and a seeker must work together as a team on

a specific code. Thus, seekers do not detect or interfere with designators set on other codes.

### **Field of View**

All seekers have a limited field of view. They must be pointed close to the target to see the laser designator spot.

### **Acquisition Time**

To avoid detection by enemy forces and to conserve battery energy, a COLT limits the amount of time it designates a target. Therefore, laser seekers and munitions have a very short time to detect the laser spot and guide to the target.

### **Sensitivity**

Different laser guidance and/or acquisition systems require various amounts of reflected laser energy to operate. Under ideal conditions, a G/VLLD must be within 5 kilometers of an average stationary target to provide optimum Copperhead guidance; whereas under ideal conditions, a Pave Penny LST can acquire an LTD spot as much as 30 kilometers away on a clear day. Less sensitive seekers are more susceptible to reflection and the relative positions of the target, designator, and seeker.

## **Seeker Types**

### **Airborne Laser Spot Tracker**

An airborne LST points out laser-designated targets to the pilot. The pilot can then attack the target with any weapons on board. Pilots require this target cue; without this assistance, it is very difficult for them to see camouflaged targets at long ranges and from high-speed aircraft. Normally, an LST uses a laser pulse code established by the COLT. An LST has a narrow field of view, and the pilot must accurately point the airplane so the seeker lines up on the laser energy.

## **Laser-Guided Missile and Copperhead Cannon-Launched Guided Projectile**

The laser-guided missile (LGM) and CLGP must be precisely aimed to see the laser energy on the target. To optimize LGM or CLGP terminal guidance, laser designation must be timed according to the LGM or CLGP predicted time of flight. If the laser designator is turned on late, the LGM or CLGP may miss; turning the laser designator on early will not cause a miss.

### **Laser-Guided Bomb**

The LGB must be aimed so that the target is within the field of view of the seeker. If the aircraft does not have an LST, a visible target mark may be required as an aiming cue. Since the laser pulse code is preset on the LGB and cannot be changed while it is airborne, the COLT must use the code set in the bomb. When the lofting or shallow delivery method is used, if the laser designator is turned on too early, the LGB will steer to the laser mark too soon and miss by falling short of the target. Whenever possible, the pilot should communicate directly with the COLT so the laser can be turned on at the best time. Delaying designation until the last 10 seconds of weapon flight is ideal. A low-level laser-guided bomb (LLLGB) does not have the LGB early lock-on characteristic.

## **Designator and Seeker Pulse Code**

Coding for laser designators and seekers is based on pulse repetition frequency. This system uses either three- or four-digit numbers made up of the numbers 1 through 8. The three- and four-digit devices are compatible. When a mix of three- and four-digit equipment is used, the first digit of the four-digit code is always 1. For example, a three-digit code of 657 would be set as 1657 on a four-digit code system. To go from a four-digit code to a three-digit code, drop the first number. For example, a four-digit code of 1246 would become a three-digit code of 246.

The joint force headquarters has overall responsibility for code management. The corps FSE manages ground switch settings and provides blocks of settings to divisions (div arty). Brigade FSE is the lowest echelon that manages code settings. It ensures that FDCs and lower FSEs have positive coordination of assigned codes. When COLTs designate for Air Force delivery systems, the FAC receives the designator code from the pilot and passes it to the COLT.

**NOTE:** The lower the PRF, the faster the lase pulse and the better the *paint* of the target. Lower codes should be assigned to the priority COLT.

Using two or more COLTs in different locations, on the same target, and on the same code offers some advantages in attacking high-payoff targets. The main advantage is that if one designator fails, the round will still have reflected energy from another laser to guide it. The LGW locks on and tracks for the designator with the strongest reflected energy.

### Employment Options

Current authorizations for light forces normally provide one COLT to each DS artillery battalion and three COLTs to div arty. The COLT is primarily used as the designator for 155-mm artillery-delivered Copperhead. However, it can be used to optimize Air Force and other aviation systems by providing target designation and laser guidance for air-delivered munitions. The COLT gives the light force commander a powerful capability to attack hard and point targets as well as area targets if the delivery systems are available. To maximize the effectiveness of the COLT while minimizing the mobility limitations of the ground designator, positioning must be carefully considered. Positioning factors include the following:

Ž Ability to support the commander's intent.

- Intelligence preparation of the battlefield.

Ž Angle T consideration for each potential shooter.

Ž Altitude as close as possible to that of the expected target (minimize vertical angle of attack).

Ž Survivability of the COLT.

Ž Desirability of survey.

Ž Maintenance of good communications.

COLTs are positioned by the FSCOORD or his representative to support the maneuver commander's overall intent. The commander approves the COLT positioning as meeting his intent during the rehearsal and/or as part of the published operation plan and/or order. The FSCOORD must consider two aspects in the COLT positioning decision – tactical and technical. The technical aspect concerns positioning to accomplish the commander's intent on the basis of where he wants to engage targets or target sets. The technical aspect concerns the angle T target engagement parameters of the Copperhead.

COLTs assigned to div arty may be task-organized to subordinate artillery battalions or retained centrally. In task-organizing COLTs, all fundamentals of organization for combat should be considered. To provide the best coverage and to allow the greatest survivability for the COLT, COLTs often are employed in pairs. This allows continuous COLT coverage during the operation. Since the COLT is a limited, valuable asset, careful consideration must precede a decision to decentralize the COLTs below brigade level. Any decentralization should be for a designated period of time, not as a matter of SOP.

Considerations in the offense are as follows:

Ž Recommend to the commander appropriate targets for laser-guided munitions.

Ž Consider using COLTS for both marking and designating operations.

Ž Consider using a COLT as an independent observer when LGMs are undesirable or unavailable.

Considerations in the defense are as follows:

Ž Consider using COLTS in pairs to ensure coverage in depth.

Ž Survey COLT positions as a high priority in the survey plan.

Ž Consider using COLTS to survey in obstacles and to cover obstacles by observation.

Ž Consider using COLTS with night sights as an early warning system.

### Current and Projected Laser Systems

The tables below show the following:

Ž Current and projected laser spot tracker systems, their general functions, and their characteristics.

Ž Description of each laser designator system.

Ž Descriptions of laser-guided weapons.

### GLOSSARY FOR TABLES

AGM	= air-ground missile	LST	= laser spot tracker
ARBS	= angle rate bombing system	LTD	= laser target designator
DD	= destroyer	MMS	= mast-mounted sight
DDG	= guided missile destroyer	MULE	= modular universal laser equipment
FAC	= forward air controller	NA	= not applicable
FIST	= fire support team	NGF	= naval gunfire
GBU	= glide bomb unit	NOS	= night observation system
G/VLLD	= ground/vehicular laser locator designator	TADS	= target acquisition system and designation sight
LANTIRN	= low-altitude navigation and targeting infrared for night system	TRAM	= target recognition attack multisensors
LGB	= laser-guided bomb	UAV	= unmanned aerial vehicle
LGW	= laser-guided weapon	USMC	= US Marine Corps
LLLGB	= low-level laser-guided bomb	USN	= US Navy
LMAV	= Laser Maverick		

## LASER SPOT TRACKERS

SYSTEM	SERVICE	LASER SPOT TRACKER OR ACQUISITION SYSTEM	TARGET DESIGNATION SYSTEM	LASER-GUIDED MUNITION	EMPLOYMENT PLATFORM	PRF CODE DIGITS	IN-FLIGHT SELECTABLE
TADS	Army	X	X		AH-64A	4	Yes
Pave Penny	Air Force	X			A-7, A-10	4	Yes
TRAM	Navy USMC	X	X		A-6E	4	Yes
MULE	USMC		X		Ground (hand-held or tripod)	3	NA
G/VLLD	Army		X		Ground (tripod or vehicle mount)	3	NA
LTD	Army		X		Ground (hand-held)	3	NA
Pave Spike	Air Force		X		F-4D, F-4E	4	Yes
Pave Tack	Air Force		X		F-4E, RF-4C, F-111F	4	Yes
LANTIRN	Air Force		X		A-10, F-15E, F-16	4	Yes
MMS	Army	X	X		OH-58D	4	Yes
Aquila	Army		X		UAV	3	Yes
NOS	USMC		X		OV-10D	3	Yes
Hellfire	Army USMC			X	AH-64A, UH-60, AH-1	4	Yes
Copperhead	Army USMC			X	155-mm howitzer	3	NA
Paveway I, II (LGB), and III (LLGB)	Air Force Navy			X	Any attack or fighter aircraft	4	No
Laser Maverick	USMC			X	A-4, AV-8, A-7, F/A-18	4	Yes
5-Inch Semiactive Laser-Guided Projectile	Navy			X	DD- and DDG-class ships	4	No
ARBS	USMC	X			A-4M, AV-8B	4	Yes
AGM-123A Skipper II	Navy USMC			X	A-6E, A-7	4	No
Laser Spot Tracker	Navy USMC	X			F/A-18	4	Yes

## LASER DESIGNATOR SYSTEMS

GROUND/VEHICULAR LASER LOCATOR DESIGNATOR (ARMY)	
<b>Description</b>	Long-range laser range finder and designator Can provide azimuth and vertical angle
<b>Function</b>	Designates targets or areas that can be detected by aircraft equipped with LST and LGWs set to same code as G/VLLD
<b>Platform</b>	Mounted: In M981 FIST vehicle Dismounted: On tripod
<b>Employment</b>	Located in company and troop FISTs and in COLTs
<b>PRF codes</b>	111 through 888 (see previous discussion)
<b>Target nominal range (for standard target 2.3 x 2.3 meters)</b>	Stationary: 5 km (Copperhead) Moving: 3 km (Copperhead)
<b>System-unique capabilities</b>	Uses night sight Two-man portable for short distances Can be mounted on the M113A1 Interim FIST vehicle
<b>Limitations</b>	Limited mobility
LASER TARGET DESIGNATOR (ARMY)	
<b>Description</b>	Battery-operated, lightweight, hand-held
<b>Function</b>	Designates targets that can be detected by aircraft equipped with LST and LGWs set to same code as LTD
<b>Platform</b>	Hand-held
<b>Employment</b>	Used by fire support personnel in airborne, ranger, and special operations forces
<b>PRF codes</b>	111 through 888 (see previous discussion)
<b>Target nominal range (for standard target 2.3 x 2.3 meters)</b>	Stationary: 1 km (Copperhead) point target Stationary: 3 km (Copperhead) area target Moving: 3 km (Copperhead)
<b>System-unique capabilities</b>	Easily transportable
<b>Limitations</b>	Cannot establish range to targets Cannot provide direction and vertical angle Limited laser-on time because of battery life
MODULAR UNIVERSAL LASER EQUIPMENT (MARINE CORPS)	
<b>Description</b>	Man-portable LTD and range finder
<b>Function</b>	Accurately locates targets and provides terminal guidance for LGWs
<b>Platform</b>	Man-packed, tripod-mounted
<b>Employment</b>	Gives forward observers, NGF spotters, and FACs the capability to accurately determine location and range to targets Provides laser designation for all surface- and air-delivered LGWs
<b>PRF codes</b>	111 through 888 (see previous discussion)
<b>Target nominal range (for standard target 2.3 x 2.3 meters)</b>	Stationary: 5 km Moving: 3 km
<b>System-unique capabilities</b>	Consists of three basic modules: <ul style="list-style-type: none"> <li>• Laser designator range finder module provides the basic laser designator and ranging equipment</li> <li>• Stabilized tracking tripod module provides stabilization for the tracking of moving targets and targets at extended ranges</li> <li>• North-finding module provides a true north reference</li> </ul>
<b>Limitations</b>	Subject to visibility restrictions of line of sight, clouds, darkness, smoke, dust, and so forth

## LASER DESIGNATOR SYSTEMS (CONTINUED)

### OH-58D MAST-MOUNTED SIGHT (ARMY)

Description	Electro-optical system incorporating television visual and thermal imaging systems and laser range finder, designator, and LST
Function	Sight system to laser-designate for other weapon systems
Platform	OH-58D
Employment	Provides day, night, and adverse weather target acquisition and laser designation capability
PRF codes	All codes; in-flight selectable
Target nominal range (for standard target 2.3 x 2.3 meters)	Stationary: 10 km Moving: 10 km
System-unique capabilities	MMS LST facilitates handoffs from other laser designators Tracks targets manually or automatically
Limitations	Subject to visibility restrictions of line of sight, clouds, darkness, smoke, dust, and so forth

## LASER-GUIDED WEAPONS

### COPPERHEAD (ARMY AND MARINE CORPS)

Description	Laser seeker in nose of projectile which homes in on laser energy reflected from the target during the final portion of trajectory
Function	Used in conjunction with a ground or airborne laser designator
Platform	Fired from M109 155-mm self-propelled howitzers and M198 155-mm towed howitzers
Employment	Used primarily to attack high-payoff moving or stationary hard point targets
PRF codes	111 through 888
Target nominal range (for standard target 2.3 x 2.3 meters)	Stationary: Minimum range 3 km, maximum range 16 km Moving: Minimum range 3 km, maximum range 16 km
System-unique capabilities	Point target accuracy Large footprint within which round can acquire target
Limitations	Requires continuous laser designation during the final 13 seconds of projectile flight

### HELLFIRE MISSILE (ARMY AND MARINE CORPS)

Description	Third generation air-launched antiaircraft laser-guided missile
Function	Used in conjunction with a ground or airborne laser designator
Platform	AH-64 helicopter
Employment	Employed against armor or other hard point-type targets Autonomous designation or <i>buddy lasing</i> for other launch platforms
PRF codes	All codes; in-flight selectable
Target nominal range (for standard target 2.3 x 2.3 meters)	Stationary: 5 km Moving: 5 km
System-unique capabilities	Can launch by use of direct or indirect method Can employ single, rapid, or ripple firing techniques Seeker lock-on options are lock-on after launch and lock-on before launch
Limitations	Subject to visibility restrictions of line of sight, clouds, darkness, smoke, dust, and so forth



### LASER-GUIDED WEAPONS (CONTINUED)

LASER MAVERICK AGM-65E (MARINE CORPS)	
Description	A short-range, laser-guided, rocket-propelled air-to-surface missile
Function	Used in conjunction with ground or airborne laser designators
Platform (with modifications)	A-4M and A-6E, F/A-18, AV-8B, A-7 (USN)
Employment	Intended for use against fortified ground installations, armored vehicles, and surface combatants Employs 125-pound warhead or 300-pound Maverick alternate warhead with selectable delay fuze
PRF codes	Classified; cockpit selectable
Target nominal range (for standard target 2.3 x 2.3 meters)	Stationary: Yes Moving: Yes Minimum: Safety considerations only Maximum: Missile seeker; searches a sector 7 miles across and over 10 miles ahead
System-unique capabilities	If missile loses laser spot, missile goes ballistic and flies up and over target Warhead does not explode; it becomes a dud Cockpit-selectable laser coding and fuzing (delay or quick)
Limitations	Subject to visibility restrictions of line of sight, clouds, darkness, smoke, dust, and so forth
LASER-GUIDED BOMB PAVEWAY I OR II (NAVY, AIR FORCE, AND MARINE CORPS)	
Description	500-pound (GBU-12) or 2,000-pound (GBU-10) warhead marked with laser guidance Two generations, Paveway I and II, are compatible with all US ground and airborne designators
Function	Bomb released after aircraft is within delivery envelope
Platform	Bomb begins terminal guidance upon laser energy acquisition
Employment	All aircraft capable of employing conventional weapons of same weight class Level or dive for Paveway I bombs; also loft for Paveway II bombs Optimum against hard point targets
PRF codes	Some set at factory; some set before takeoff
Target nominal range (for standard target 2.3 x 2.3 meters)	Stationary: Up to 6 km Moving: Yes Function of designator-to-target range, designator output, and ballistic delivery range
System-unique capabilities	Accuracy gives high probability of target kill against point targets
Limitations	Early laser lock-on during a loft or shallow delivery angle tends to cause a miss short Requires ballistically accurate delivery and continuous laser energy during last 10 seconds of time of flight Target must subtend 1 mil (at designator-to-target range) Very limited low-altitude capability When delivered from a low-altitude loft maneuver, restricts laser on target to last 10 seconds of flight time
LASER-GUIDED BOMB PAVEWAY III (NAVY, AIR FORCE, AND MARINE CORPS)	
Description	Designated GBU-24 (2,000-pound bomb) No 500-pound version Third-generation LGB
Function	Same as Paveway I or II
Platform	Same as Paveway I or II
Employment	Expanded delivery envelopes allowing very low-altitude, relatively-low-ceiling, longer-range weapon releases
PRF codes	Retains dive delivery option

**LASER-GUIDED WEAPONS (CONTINUED)**

<b>Target nominal range</b> (for standard target 2.3 x 2.3 meters)	Same as Paveway I and II Same as Paveway I and II
<b>System-unique capabilities</b>	Improved accuracy capability over LGB GBU-10 or 12 Highly resistant to countermeasures Blind launch capability from extended ranges If LLLGB does not detect laser energy, it will maintain level flight and fly beyond the target
<b>Limitations</b>	Requires continuous laser energy during last 8 seconds of time of flight Target must subtend 1 mil (at designator-to-target range)